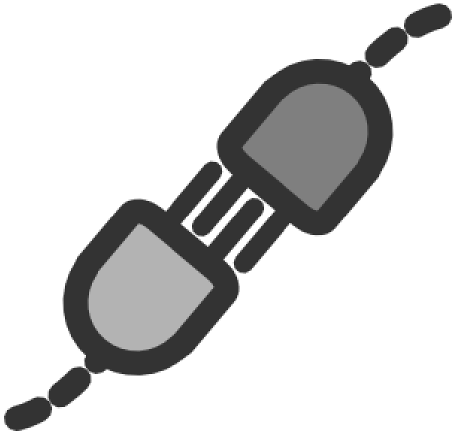
FERC Technical Conference -

on issues related to a petition submitted by the Solar Energy Industry Association



July 17, 2012
FERC

Pepco Holdings, Inc

Overview

- Introduction – Pepco Holdings, Inc. PV Activity
- Hosting Capacity Factors
- Fast Track15% Screen, 2 MW limit
- Load Data Collection & the proposed 100% Minimum Daytime Load Screen
- Required Upgrades for interconnection – Recommendation for 3rd Party to review
- EPRI Hosting Capacity Study

Pepco Holdings, Inc.

3 states and Washington DC in mid-Atlantic US

pepco — A PHI Company

648 sq mi (*575 in MD)*

782,000 cust (*528,000 in MD)*

4 and 13kV distribution

delmarva power — A PHI Company

5,400 sq mi (*3,500 in MD)*

498,000 cust (*199,000 in MD)*

4, 12, 25 and 34kV distribution

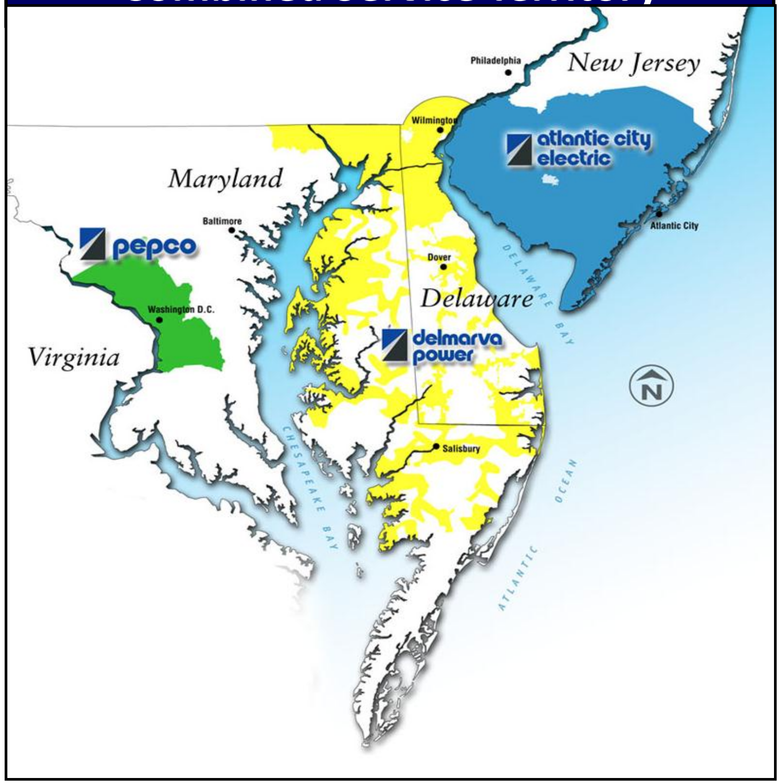
atlantic city electric — A PHI Company

2,700 sq mi

546,000 cust

4, 12, 23, and 34kV distribution

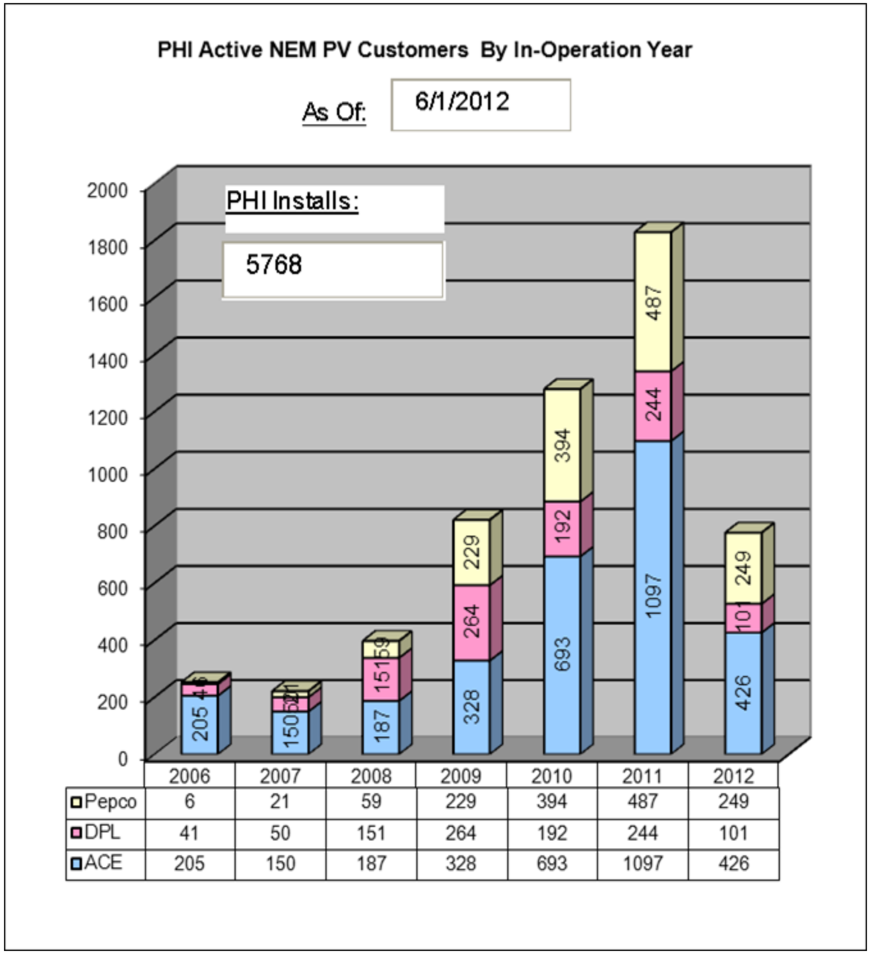
Combined Service Territory

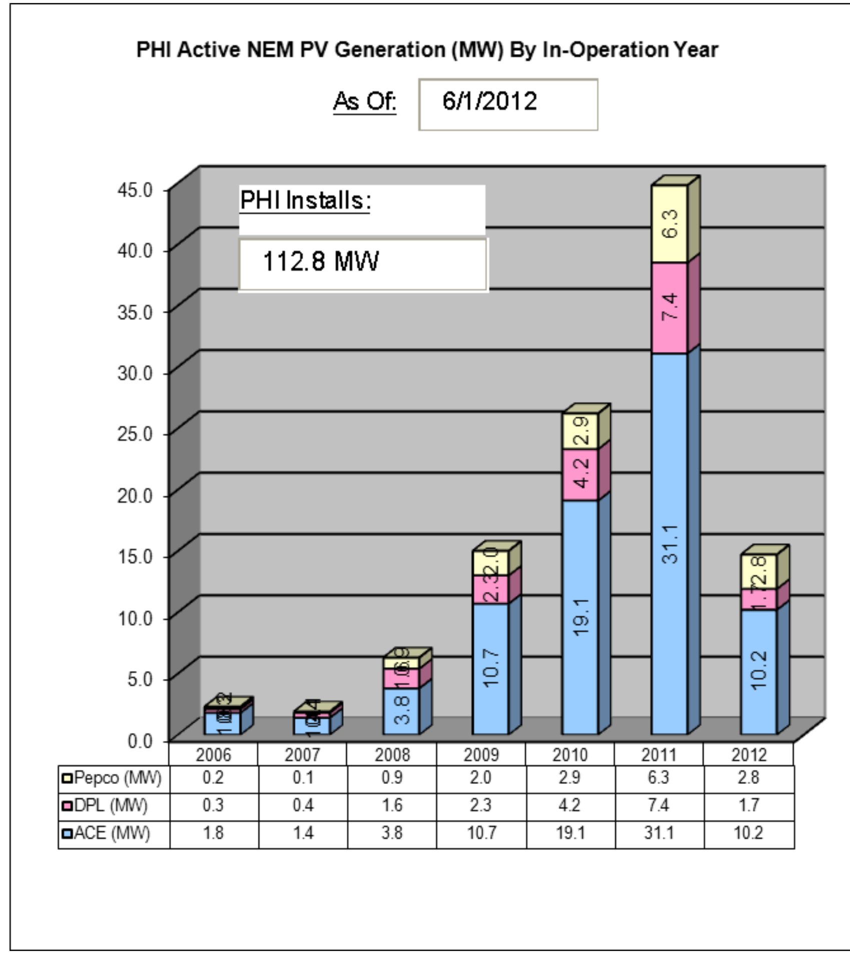


PHI Solar Activity

- PHI Supports Solar Integration in all our Jurisdictions
- Has made the SEPA top ten list for both the amount and watts/customer of PV integrated in Atlantic City Electric
- While PHI supports increased solar and other Distributed Energy Resource additions, we remain focused on maintaining a reliable grid for all customers.
- PHI is supporting many efforts to develop advanced technology that will accommodate more PV and other renewables on the grid safely and reliably.
- If solar installations cause negative impacts on the grid, it will ultimately hurt the solar industry in our country.

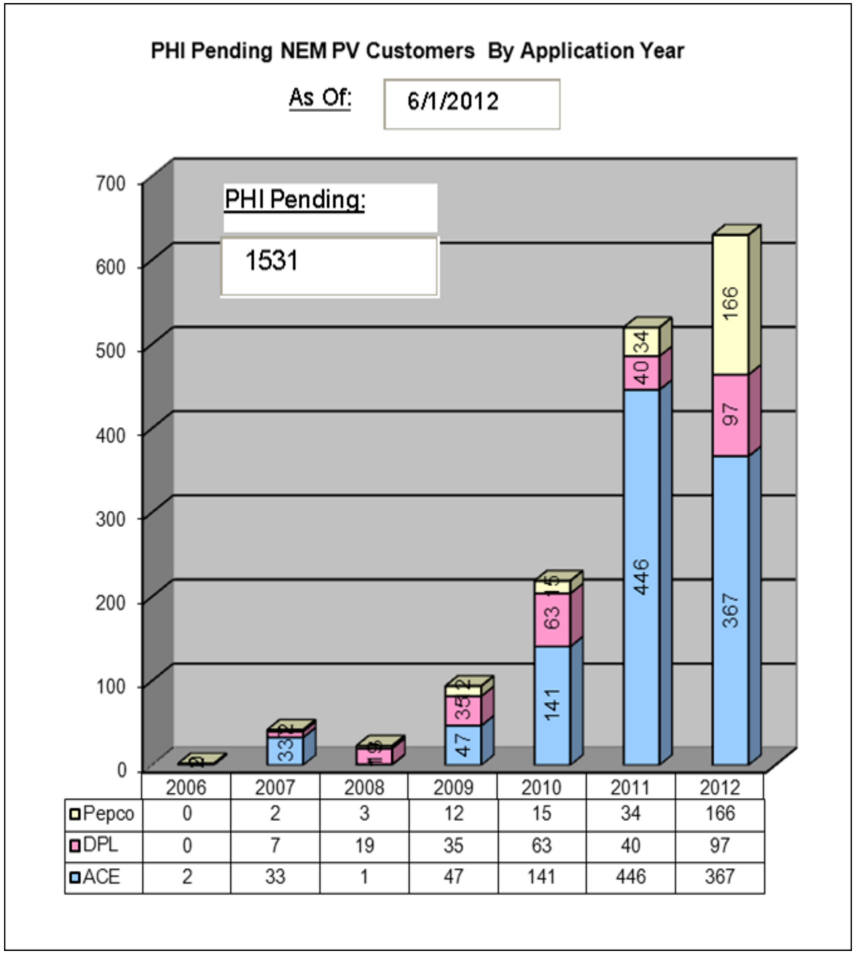
Active NEM PV CUSTOMERS & MWS



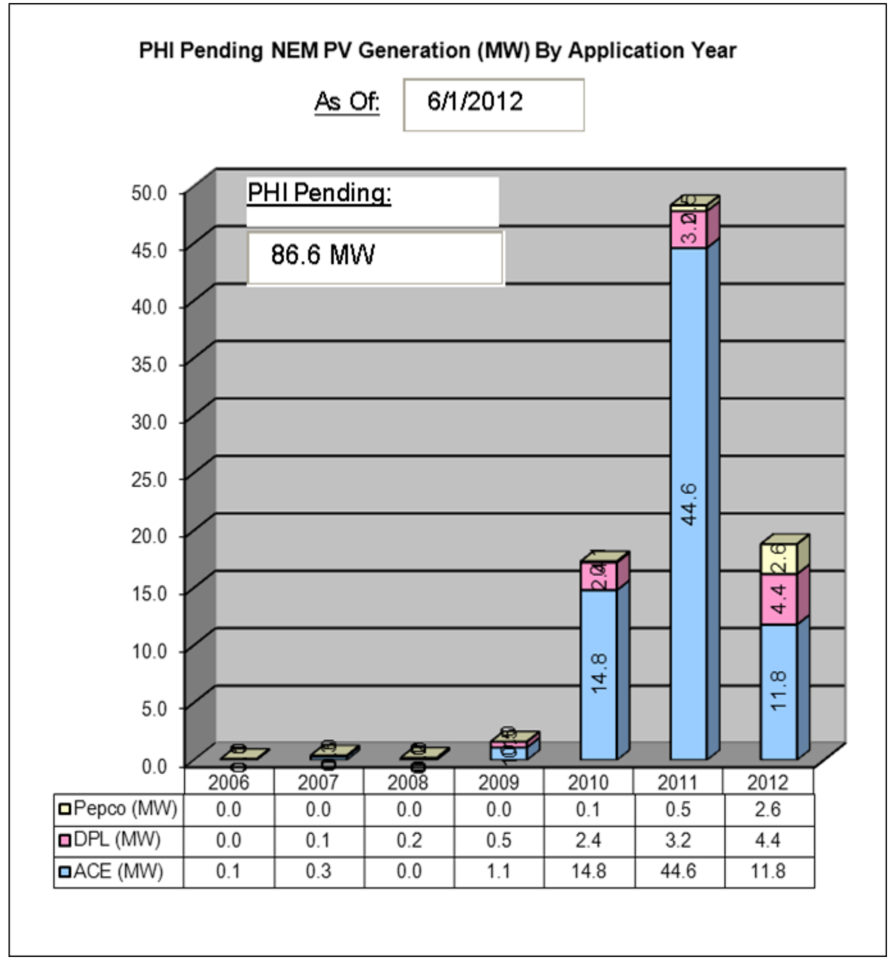


ACE	DPL	PEPCO	TOTAL	ACE	DPL	PEPCO	TOTAL
3259	1061	1448	5768	79.3 MW	18.3 MW	15.2 MW	112.8 MW

Pending NEM PV CUSTOMERS & MWS



	2006	2007	2008	2009	2010	2011	2012
Pepco	0	2	3	12	15	34	166
DPL	0	7	19	35	63	40	97
ACE	2	33	1	47	141	446	367



	2006	2007	2008	2009	2010	2011	2012
Pepco (MW)	0.0	0.0	0.0	0.0	0.1	0.5	2.6
DPL (MW)	0.0	0.1	0.2	0.5	2.4	3.2	4.4
ACE (MW)	0.1	0.3	0.0	1.1	14.8	44.6	11.8

ACE	DPL	PEPCO	TOTAL
1038	261	232	1531

ACE	DPL	PEPCO	TOTAL
72.6 MW	10.7 MW	3.3 MW	86.6 MW

Pepco Holdings, Inc

Pending Wholesale Projects: 803 MWS

***Hosting Capacity Factors** (not exhaustive)*

- Distance to POI (Impedance of system at POI)
- Size & Distribution of DER(s)
- Proximity & Impact on Voltage Regulators and Capacitors
- Peak & Minimum Daytime Load
- Existing Voltage Regulation Scheme(s) & Requirements
- Effect of added DER(s) on phase balance
- Distribution Automation Schemes (Automatic Sectionalizing and Restoration)

EPRI Hosting Capacity Study Summary

(supporting slides at end of hand out)

- Multiple sensing points were installed on the feeder to measure electrical parameters and irradiance at one second intervals. One second interval data was also collected on a 1.7 MW solar farm located 4.7 miles from the substation on the rural feeder selected for this study.

- EPRI developed a detailed model of the feeder, validated it with actual data, then did analysis to determine hosting capacity factors related to different criteria – Voltage, Loading, Protection, Power Quality, and Operational. Some capacity factors were as low as 3.3% of peak.

- The final slide compares the very different hosting capacity for the rural (J1) feeder to an urban (K1) feeder of similar voltage class and peak that was analyzed in the same way.

Case Study on the 15% Screen

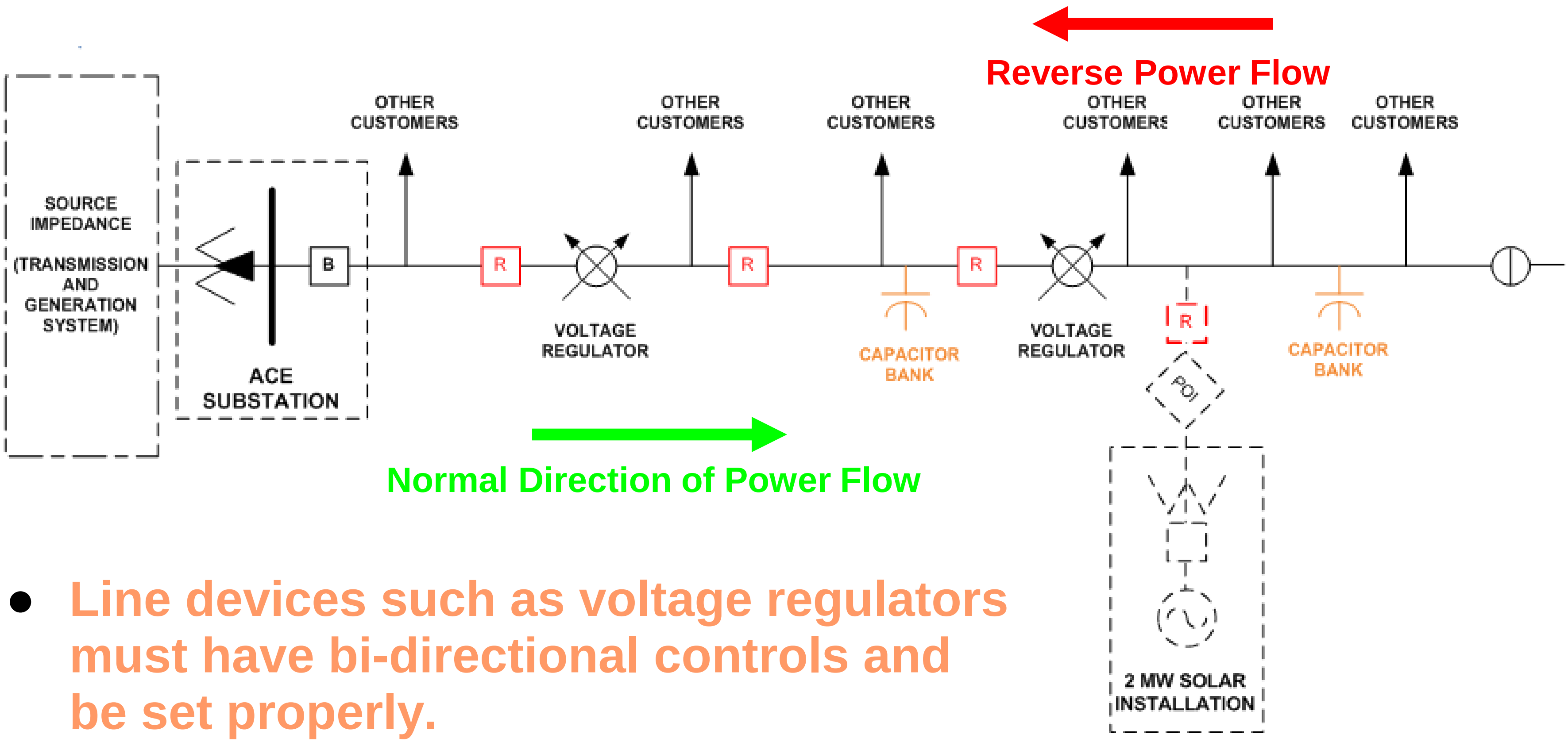
- PV System Capacity: 1.33 MW AC
- 1.8 miles from the substation to POI
- Circuit Peak Load = 8.5 MVA, Circuit Voltage: 12,470 Ph to Ph
- 15% of Peak Load = 1.3 MVA

- Screens:
- Installed PV – 15% Screen (Borderline)
- Short Circuit Screen: 4.0% fault contribution at POI (Pass)
- 87.5% of Rating Screen: (Pass)

Problem that Occurred

- The circuit experienced reverse flow on several spring weekends. Further review showed low daytime load on the weekend to be very close to 15% of peak.
- The reverse flow caused a regulator(s) at the sub. with non-reversible controls, to operate to max raise on the line side. This occurred on one or two phases several times.
- This resulted in high voltage on the circuit and damage to some customer equipment.
- Several inverters tripped after the fact but didn’t prevent overvoltage.
- The reverse flow on the substation power transformer caused an unacceptable condition from a system protection standpoint

Typical Circuit Diagram



- **Line devices such as voltage regulators must have bi-directional controls and be set properly.**
- **Substation Power transformer shouldn't have reverse flow w/o transfer trip to the generator.**

Summary – 15% Screen & 2MW limit

- The 15% screen is good for the vast majority of circuits and should be maintained, however should not be viewed as a fail safe screen and utilities should have the discretion of doing further study when initial Investigation warrants.

- The situation in the case study can easily be repeated on feeder regulation zones, by the addition of small or large PV systems in aggregate, causing reverse flow on a voltage regulator not set up for that condition.

- As more and more solar is integrated over the period of time, the historical Peak, and daytime loads become masked and the screen becomes more difficult to use accurately.

- DA and Reconfiguration schemes must also be considered.

- Systems less than 2MWs can have significant impact , so the 2MW threshold should remain.

Load Data Collection & Proposed 100% Minimum Daytime Load Screen

- Availability and Quality of Data
  - Some feeders do not have this data
  - Most feeders do not have load data by section
  - Phase imbalance and metering inaccuracy or estimation error would need to be accounted for
  - Installed PV masking and changes due to weather, economics, DERs on/off, etc. must be taken into account
  - Pending systems and those with ISDs after historical load measurement increases the complexity and must be taken into account when providing this type of data

Load Data Collection & Proposed 100% Minimum Daytime Load Screen (cont.)

- DA and restoration Schemes must be considered
- Other FERC screens still apply
- If the practice of providing data is started, this type of data would have to be published on a public website to insure no preferential treatment and would have to be updated frequently to be of value
- Since this data alone would not insure that a developer could put a system of a particular size at a certain location on a feeder, and it would require significant effort, the utility would not favor this change.

3rd Party Review of Upgrades

- Currently PHI has detailed impact studies done by a 3rd party

- Some Concerns with 3rd Party reviews:
  - Each utility has its own Planning and Operating Criteria and Construction Standards based on National and State Standards and best industry practices. The third party must follow these when assessing the recommended upgrades.
  - It will add time and cost to studies. There will be added effort by the utility to explain the study results, study criteria, construction standards, etc. to provide the needed information for the 3rd Party to do the review.

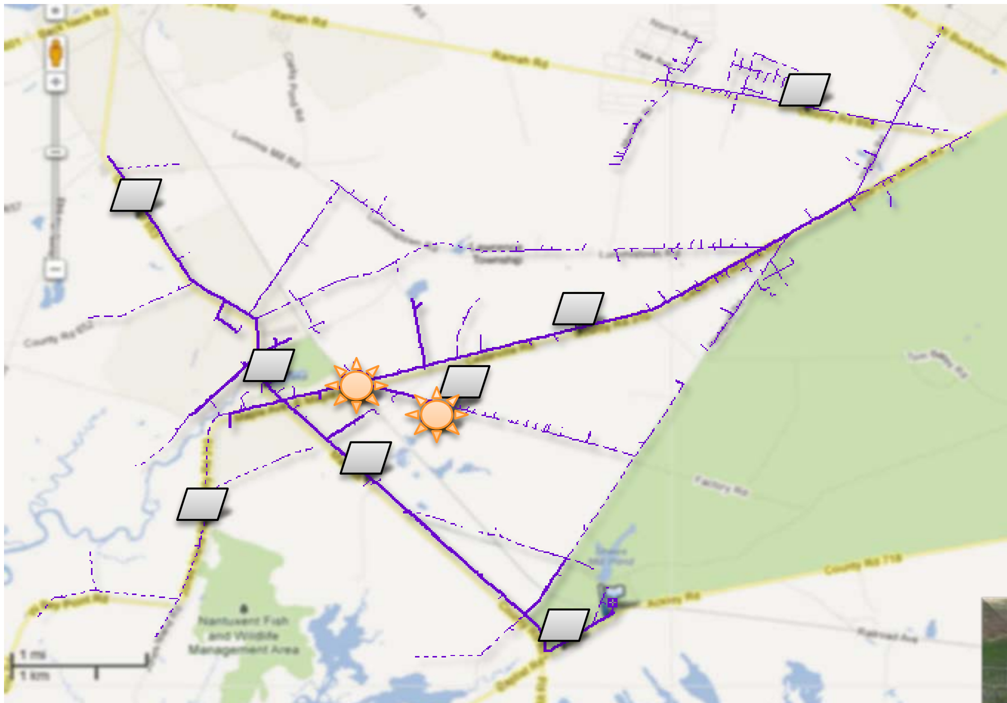
Recommendation for Alternative to Screening Requirements

- To save time and money for the developer and provide both faster and more detailed analysis, PHI is acquiring a "semi-automated study tool" that will work inside a time series electric load flow program. This promises to be fast, handle unbalanced load flow, to evaluate new projects while representing existing and pending projects and provide a much more accurate impact assessment. If FERC modifies the pro forma SGIP, it should incorporate some flexibility for utilities to take advantage of advanced tools such as those being procured by PHI.

Selected Slides from EPRI Hosting Capacity Study

- Sites where measurement data was collected
- How hosting capacity is determined
- Electrical Model Characteristics
- Impact of existing PV
- Summary of minimum hosting capacity
- Comparison to other utility feeder – Rural versus Urban

Measurement Data
Solar Monitoring



DPV Pole-Mount Panels
Metered Large-Scale PV

How is Hosting Capacity Determined?

Answer: PV Penetration Level When a Criteria Boundary ***Flag*** is Exceeded

Category	Criteria	Flag
Voltage	Overvoltage	≥ 1.05 Vpu
	Voltage Deviation	≥ 0.833% (½ of 2V regulator bandwidth)
	Unbalance	≥ 3%
Loading	Thermal	≥ 100% normal rating
Protection	Total Fault Contribution	≥ 10% increase
	Forward Flow Fault Contribution	≥ 10% increase
	Sympathetic Tripping	≥ 150A
	Reduction of Reach	≥ 10% decrease
	Fuse Saving	≥ 100A increase
	Anti-Islanding	≥ 50% minimum load
Power Quality	Individual Harmonics	≥ 3%
	THDv	≥ 5%
Operational*	Regulator duty	> Basecase +1
	Capacitor duty	> Basecase +1

*Operational requires time-series irradiance data

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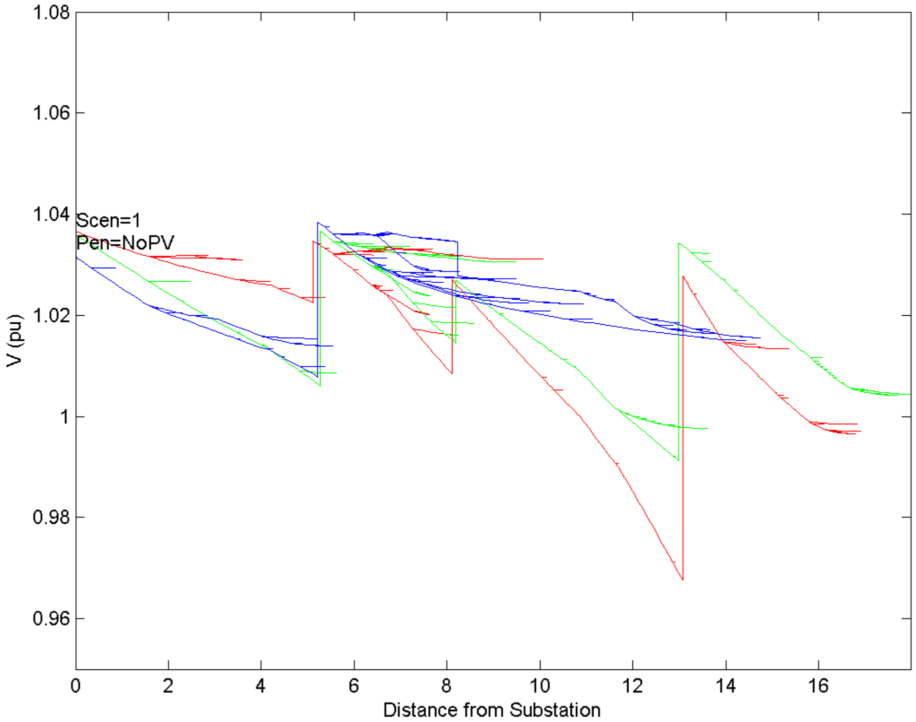
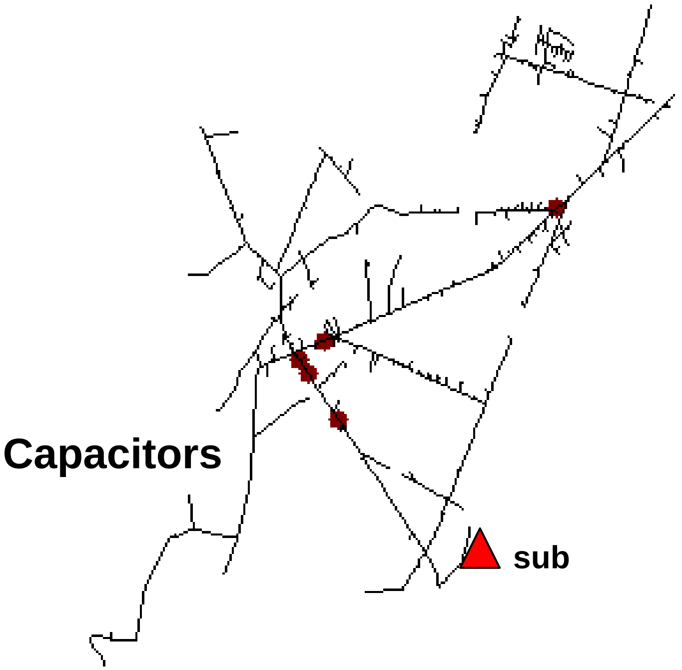
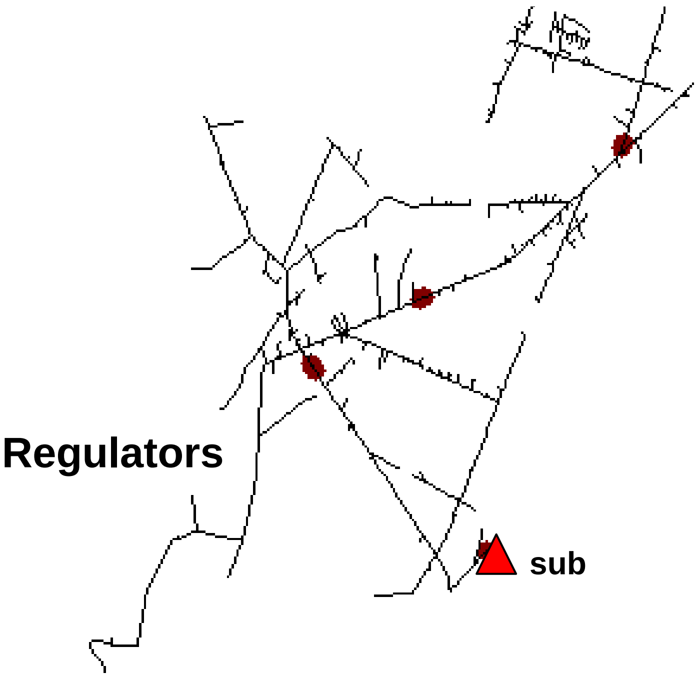
Model Characteristics
Control

- Four Regulation Zones
- Existing Control
  - 5 capacitors
  - 9 regulators



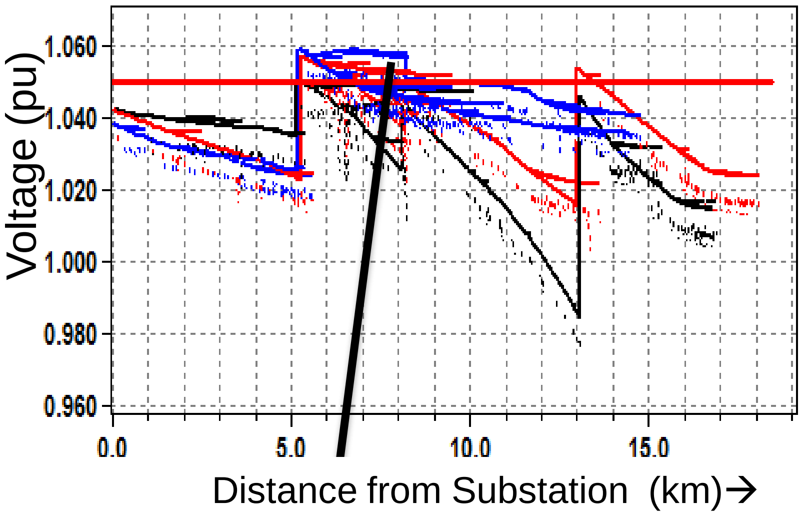


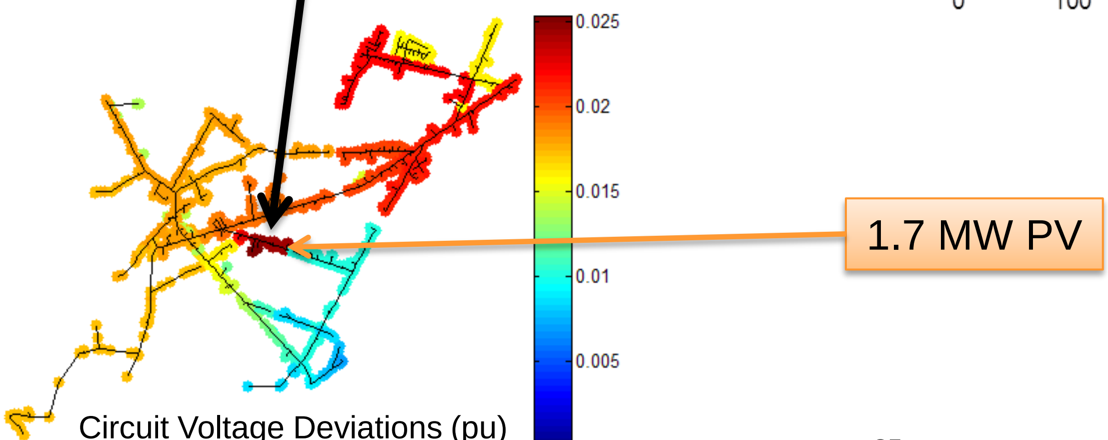


Existing PV Has Adverse Impact to Feeder

Verified Via Measurements AND Simulation

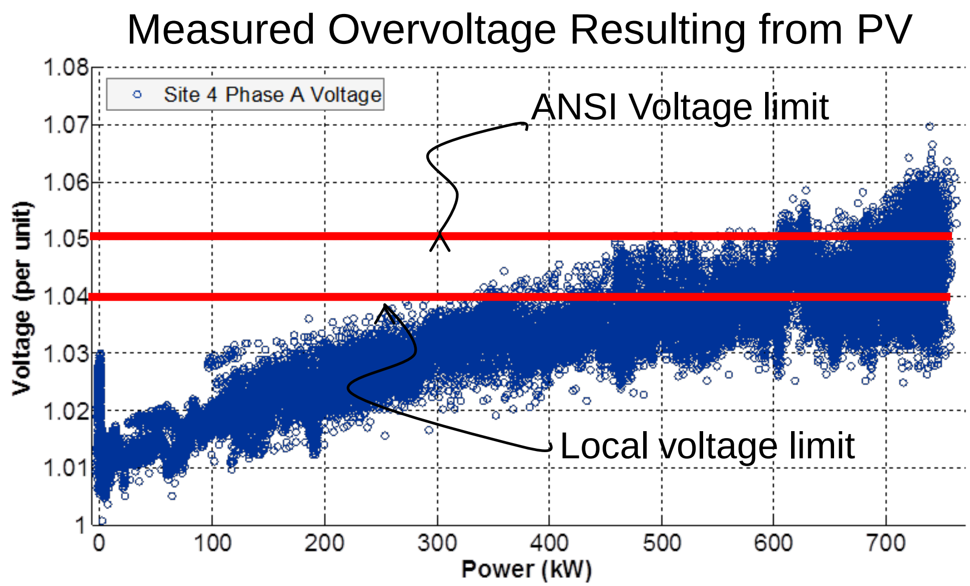
Simulation





Circuit Voltage Deviations (pu)

Measurements



Increasing PV Output →

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Stochastic/Time Series Results

Overall Summary of Minimum Hosting Capacity

Category	Criteria	Small Scale (kW)	Large Scale (kW)
Voltage	Primary Overvoltage	421	500
	Regulator Deviation	249	500
	Primary Imbalance	490	>10000
Loading	Thermal	>5000	7500
Protection	Total Fault Contribution	1685	500
	Forward Flow Fault Contribution	2253	500
	Sympathetic Tripping	1426	500
	Reduction of Reach	1489	500
	Fuse Saving	1426	500
	Anti-Islanding – Breaker	390	390
Power Quality	Individual Harmonics	0*	0*
	THDv	0*	0*
Operational	Regulator	249	500
	Capacitor	249	500

* Basecase exceeded threshold

Comparison to Other Utility Feeder

- Each feeder has **similar** characteristics that are **typically** used to classify feeders (load level and voltage class)
- Two significantly different PV penetration levels can be accommodated before violating voltage criteria

		Feeder J1		Feeder K1	
Category	Criteria	Small Scale (kW)	Large Scale (kW)	Small Scale (kW)	Large Scale (kW)
Voltage	Primary Overvoltage	421	500	>3585	8000
	Regulator Deviation	249	500	>3585	>10000
Protection	Total Fault Contribution	1685	2500	>3585	7500
	Forward Flow Fault Contribution	2253	2500	>3585	10000
	Sympathetic Tripping	1426	>10000	1478	>10000
	Reduction of Reach	1489	2500	>3585	5000
	Fuse Saving	1426	5000	1771	5000
	Anti-Islanding – Breaker	390	390	777	777

Steve Steffel, PE

Mgr, Distributed Energy Resources Planning and Analytics

Steve.Steffel@pepcoholdings.com

Pepco Holdings, Inc